(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（A）　(11)特許出願公開番号
特開2000－243573
（P2000－243573A）
(43)公開日　平成12年9月8日(2000.9.8)

(51)Int.Cl.7	識別記号	FI	テーマコード（参考）
ＨＯ５Ｂ　33/22		ＨＯ５Ｂ　33/22	Ｃ　３Ｋ００７
			Ａ
33/10		33/10	
33/14		33/14	Ａ

審査請求　未請求　請求項の数５　ＯＬ　（全 ６ 頁）

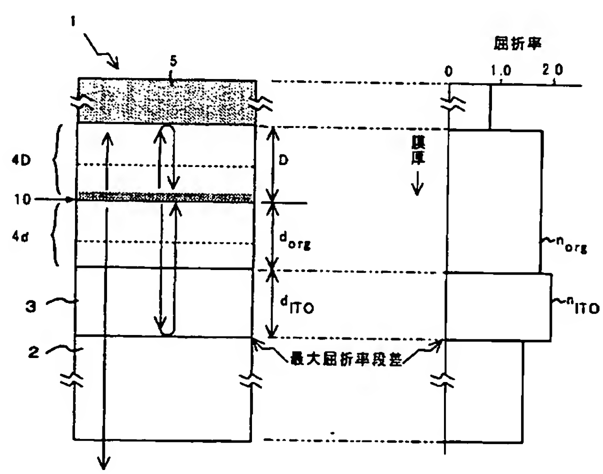
(21)出願番号　特願平11－39604
(22)出願日　平成11年２月18日(1999.2.18)

(71)出願人　000005016
パイオニア株式会社
東京都目黒区目黒１丁目４番１号
(72)発明者　福田　善教
埼玉県鶴ヶ島市富士見６丁目１番１号　パイオニア株式会社総合研究所内
(74)代理人　100079119
弁理士　藤村　元彦

Ｆターム(参考)　3K007 AB03 AB04 AB06 AB08 CA01 CB01 CB04 CC01 DA01 DB03 DC05 EB00 FA01

(54)【発明の名称】　有機エレクトロルミネッセンス素子とその製造方法

(57)【要約】
【課題】　透明電極と金属電極との間のリーク電流の発生を抑制した有機エレクトロルミネッセンス素子を提供する。
【解決手段】　透光性の基板上に少なくとも、透明電極と、発光層を含む有機化合物材料層と、金属電極と、が順に積層されて形成され、発光層の発光界面を境にした透明電極側の有機化合物材料層又は透明電極に最大屈折率段差の界面を有する有機エレクトロルミネッセンス素子であって、透明電極側の有機化合物材料層は、有機化合物材料層の透明電極側の膜厚に対する発光効率特性における１次極大値及び２次極大値の発光効率の間の極小値を生じる膜厚以上となるように、形成されている。



も、透明電極と、発光層を含む有機化合物材料層と、金属電極と、が順に積層されて形成され、前記発光層の発光界面を境にした透明電極側の前記有機化合物材料層又は前記透明電極に最大屈折率段差の界面を有する有機エレクトロルミネッセンス素子であって、前記透明電極側の有機化合物材料層は、前記有機化合物材料層の透明電極側の膜厚に対する発光効率特性における１次極大値及び２次極大値の発光効率の間の極小値を生じる膜厚以上となるように、形成されていることを特徴とする。

【０００７】本発明による有機エレクトロルミネッセンス素子においては、前記有機化合物材料層の透明電極側の膜厚は、波長λの光を主成分として発光する前記発光層の発光界面から前記最大屈折率段差の界面までの光学距離が前記波長λの１／４の偶数倍と略等しくなるように、成膜されていることを特徴とする。本発明による有機エレクトロルミネッセンス素子においては、前記有機化合物材料層の金属電極側の膜厚は、前記発光層の発光界面から前記金属電極との界面までの光学距離が前記波長λの１／４の奇数倍と略等しくなるように、成膜されていることを特徴とする請求項２記載の有機エレクトロルミネッセンス素子。

【０００８】また、本発明による有機エレクトロルミネッセンス素子の製造方法は、透光性の基板上に少なくとも、透明電極と、発光層を含む有機化合物材料層と、金属電極と、が順に積層されて形成され、前記発光層の発光界面を境にした透明電極側の前記有機化合物材料層又は前記透明電極に最大屈折率段差の界面を有する有機エレクトロルミネッセンス素子の製造方法であって、透光性の基板上に形成された透明電極上に、波長λの光を主成分として発光させるべき発光層を除く前記有機化合物材料層のうちの１つ以上の層を、前記発光層の発光界面から前記最大屈折率段差の界面までの光学距離が前記波長λの１／４の偶数倍と略等しくなるような膜厚で、積層して、透明電極側の前記有機化合物材料層を形成する第１の有機化合物材料層形成工程と、前記透明電極側の前記有機化合物材料層上に発光層及び残る前記有機化合物材料層を、前記発光層の発光界面から前記金属電極との界面までの光学距離が前記波長λの１／４の奇数倍と略等しくなるような膜厚で、積層して、金属電極側の前記有機化合物材料層を形成する第２の有機化合物材料層形成工程と、前記金属電極側の有機化合物材料層上に金属電極を形成する金属電極形成工程と、からなることを特徴とする。

【０００９】本発明による有機エレクトロルミネッセンス素子の製造方法において、前記有機化合物材料層及び金属電極は、蒸着により積層されることを特徴とする。本発明によれば、有機化合物材料層の膜厚、特に透明電極側膜厚を厚くしていくと高次の発光効率ピークが出現する現象を利用し、透明電極と発光層との間に位置する有機化合物材料層の膜厚を調整することにより、発光効率（電流に対する輝度比）を悪化させることなくリーク防止を達成した素子を提供することができる。

【００１０】

【発明の実施の形態】本発明による有機ＥＬ素子及びその製造方法の実施例を図面を参照しつつ説明する。発明者は有機化合物材料層の透明電極側膜厚を順次厚くした有機ＥＬ素子の複数の特性を調べた結果、有機ＥＬ素子において有機化合物材料層の透明電極側膜厚を厚くすることにより高次の発光効率ピークが出現する現象を知見し、本発明に到った。

【００１１】有機ＥＬ素子において発光層中での発光強度の分布は、正孔輸送層などが存在する透明電極側の境界面においては強く、電子輸送層などが存在する金属電極側に向かうほど減少し、発光層の膜厚に関する指数関数分布であり、かかる透明電極側の界面が発光強度ピークを有する発光界面として知られている。図３に示すように、ガラス基板２上に、ＩＴＯの透明電極３、発光層を含む複数の有機化合物材料層４ｄ及び４Ｄ、金属電極５を順次、積層した構造の有機ＥＬ素子１において、有機化合物材料層は、発光層の発光界面１０を境にして透明電極側４ｄと金属電極側４Ｄに分けられる。　図３に示すように、有機ＥＬ素子１において、金属電極５及び有機化合物材料層４Ｄの界面は全反射面とみなすことができる。よって、発光層の発光界面１０から金属電極へ向かう光は金属電極５で全反射され、発光界面１０を通過して、外部発光に寄与する。もちろん、透明電極３へ向かう光のほとんどは基板２を通過して、外部発光に寄与する。

【００１２】一方、ガラス基板２と透明電極３の屈折率段差は他の隣接層の屈折率差よりも格段に大きいので、かかる透明電極側に最大屈折率段差の界面は反射面として作用も顕著である。有機化合物材料層４ｄ、４Ｄでは屈折率は略１．８程度で、ＩＴＯ透明電極３では屈折率は略２．０程度で、ガラス（ソーダライムガラス）基板２では屈折率は略１．５程度であるので、有機化合物材料層４ｄ及び透明電極３間の屈折率差は０．２で、ガラス基板２及び透明電極３間の屈折率差は０．５であり、透明電極側ではガラス基板２及び透明電極３の屈折率差が最大である。よって、発光層の発光界面１０から透明電極３へ向かい発光界面１０へ戻る光では、有機化合物材料層４ｄ及び透明電極３間などの小さな屈折率差を無視してガラス基板２及び透明電極３の最大屈折率段差を考慮する。なお、最大屈折率段差は、ガラス基板及び透明電極だけでなく、有機化合物材料層４ｄ内部にも高い屈折率材料を成膜して形成することもできる。

【００１３】これにより、素子では図３のように、発光界面で発生した光放出ルートは、主に、（１）発光界面から直接外部へ向かい放出、（２）金属電極で外面反射して発光界面に戻って外部へ向かい放出、及び（３）ガラスで内面反射して発光界面に戻って外部へ向かい放

膜厚に関する駆動電圧及び逆方向電圧の特性を示す。

【００２３】図７から明らかなように、対電流輝度効率は、図には現れていないが１次のピークが２０nm膜厚近傍に生じると推測され、更にＴＰＤ膜厚を厚くしていくと、極小値が１００nm膜厚近傍に生じ、２次のピークが１８０nm膜厚近傍に生じていることがわかる。よって、ＴＰＤ膜厚を厚くしても高次のピークに合せ込むことで、実用的な素子特性が得られる。すなわち、有機化合物材料層の透明電極側のＴＰＤ膜厚に対する発光効率特性における１次極大値及び２次極大値の発光効率の間の極小値を越える膜厚１２０nm以上、好ましくは１７０～２００nmの膜厚となるＴＰＤを有する素子が実用的な素子となる。また、図７から明らかなように、かかる素子は、ＴＰＤ膜厚を厚くしていくと、対電流駆動電圧及び耐久電圧は上昇し、１次極大値及び２次極大値の発光効率の間の極小値を生じる膜厚１２０nm以上では十分な耐電圧特性を有することがわかる。

【００２４】さらに、本発明により、蒸着形成される有機化合物材料層の厚さを厚くすることにより、図２に示すようにゴミの陰となる部分６ａでの有機化合物材料層４の肉薄部分も十分となり素子のリークは発生しにくい。上記実施例の透明電極側の有機化合物材料層上に発光層及び残る有機化合物材料層を積層する第２の有機化合物材料層形成工程では、発光層の発光界面から金属電極との界面までの光学距離が波長λの１／４の奇数倍と略等しくなるような膜厚で、金属電極側の有機化合物材料層を形成しているが、明るさの視角依存性を考慮してこれを向上させるために、特許第２８４３９２４号に記載されているように、膜厚輝度減衰特性に応じて、発光層を含む金属電極側の有機化合物材料層を設定膜厚よりも薄く形成しても良い。

【００２５】また、上記実施例では最大屈折率段差の界面であるガラス基板２と透明電極３の界面のみ反射面として考慮したが、この間に半透明層を設けることで積極的に反射面として活用してもよい。また、透明電極の屈折率よりも極端に大きい屈折率を有するガラス基板を用いて界面を反射層として作用させるときは、光の反射前後で位相差πが生じることを考慮して膜厚Ｄを設定すればよい。また、正孔輸送層ではなく正孔注入層の膜厚を変化させてもよく、正孔注入層を成膜せずにＩＴＯ陽極１上に正孔輸送層を形成した構造でも良い。

【図面の簡単な説明】

【図１】有機ＥＬ素子を示す断面図である。

【図２】製造過程における有機ＥＬ素子を示す断面図である。

【図３】本発明による有機ＥＬ素子を示す断面図である。

【図４】本発明による有機ＥＬ素子の有機化合物材料層における内面反射を示す断面図である。

【図５】本発明による有機ＥＬ素子の有機化合物材料層における外面反射を示す断面図である。

【図６】本発明による有機ＥＬ素子の実施例の断面図である。

【図７】本発明による有機ＥＬ素子の正孔輸送層膜厚に関するＬ／Ｉ効率、輝度効率及び外部量子効率の特性を示すグラフである。

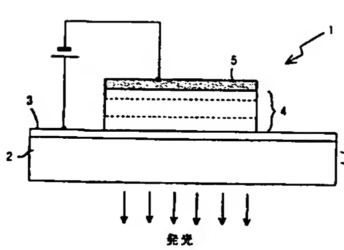
【図８】本発明による有機ＥＬ素子の正孔輸送層膜厚に関する駆動電圧及び逆方向電圧の特性を示すグラフである。

【図９】　本発明による有機ＥＬ素子の他の実施例の断面図である。

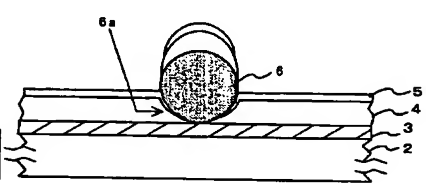
【符号の説明】

１　有機ＥＬ素子
２　透明基板
３　透明電極
４　有機化合物材料層
５　金属電極
１０　発光界面
４１　正孔注入層
４２　正孔輸送層
４３　発光層
４４a　電子輸送層
４４　電子注入層

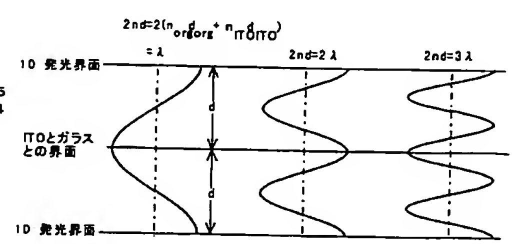
【図１】



【図２】



【図４】



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-243573
(43)Date of publication of application : 08.09.2000

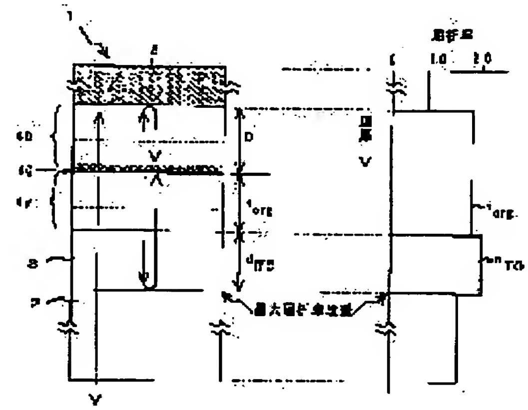
(51)Int.Cl. H05B 33/22
H05B 33/10
H05B 33/14

(21)Application number : 11-039604
(22)Date of filing : 18.02.1999

(71)Applicant : PIONEER ELECTRONIC CORP
(72)Inventor : FUKUDA YOSHINORI

(54) **ORGANIC ELECTROLUMINESCENT ELEMENT AND MANUFACTURE THEREOF**

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an element capable of restricting generation of leak current by forming film thickness of an organic compound material layer provided at a transparent electrode side of an element formed by laminating a transparent electrode, an organic compound material including a light emitting layer, and a metal electrode at a film thickness, which generates the minimum value between the primary maximal value and the secondary maximal value of the light emitting efficiency characteristic in relation to the film thickness, or more.
SOLUTION: An organic compound material layer 4d except for a light emitting layer is laminated on a transparent electrode 3 formed on a translucent substrate 2 by deposition till an optical distance from a light emitting interface 10 of the light emitting layer to the interface having the maximum refraction factor stage difference becomes an even number time of 1/4 of the light emitting wave length ,,. The light emitting layer and an organic compound material layer 4D of a metal electrode 5 side are laminated on the organic compound material layer 4d of the transparent electrode 3 side till the optical distance from the light emitting interface 10 of the light emitting layer to the interface of the metal electrode 5 becomes an odd number time of 1/4 of the light emitting wave length ,,, and the metal electrode 5 is formed thereon. With appearance of the light emitting efficiency peak having 'a high degree of priority, the organic EL element capable of restricting the generation of leak current can be obtained.



LEGAL STATUS

[Date of request for examination]	24.02.2003
[Date of sending the examiner's decision of rejection]	
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[Patent number]	
[Date of registration]	
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CLAIMS

[Claim(s)]
[Claim 1] The organic compound ingredient layer which contains a transparent electrode and a luminous layer at least on the substrate of translucency, It is the organic electroluminescent element which the laminating of a metal electrode and the ** is carried out to order, they are formed in it, and has the interface of the maximum refractive-index level difference in said organic compound ingredient layer or said transparent electrode by the side of the transparent electrode bordering on the luminescence interface of said luminous layer. The organic compound ingredient layer by the side of said transparent electrode so that it may have the thickness more than the thickness which produces the minimal value between the luminous efficiency of the primary maximal value in the luminous efficiency property over the thickness by the side of the transparent electrode of said organic compound ingredient layer, and the secondary maximal value The organic electroluminescent element characterized by being formed.
[Claim 2] For the thickness by the side of the transparent electrode of said organic compound ingredient layer, the optical path from the luminescence interface of said luminous layer which emits light considering the light of wavelength lambda as a principal component to the interface of said maximum refractive-index level difference is the organic electroluminescent element according to claim 1 characterized by the thing which one fourth of even times, abbreviation, etc. for said wavelength lambda spread, and which is formed so that it may become.
[Claim 3] The thickness by the side of the metal electrode of said organic compound ingredient layer is an organic electroluminescent element according to claim 2 characterized by the thing for which the optical path from the luminescence interface of said luminous layer to an interface with said metal electrode spreads one fourth of odd times, abbreviation, etc. for said wavelength lambda, and which is formed so that it may become.
[Claim 4] The organic compound ingredient layer which contains a transparent electrode and a luminous layer at least on the substrate of translucency, It is the manufacture approach of an organic electroluminescent element of the laminating of a metal electrode and the ** being carried out to order, they being formed in it, and having the interface of the maximum refractive-index level difference in said organic compound ingredient layer or said transparent electrode by the side of the transparent electrode bordering on the luminescence interface of said luminous layer. One or more of said organic compound ingredient layers except the luminous layer which should make the light of wavelength lambda emit light as a principal component on the transparent electrode formed on the substrate of translucency By becoming thickness on which the optical path from the luminescence interface of said luminous layer to the interface of said maximum refractive-index level difference spreads one fourth of even times, abbreviation, etc. for said wavelength lambda The 1st organic compound ingredient layer formation process which carries out a laminating and forms said organic compound ingredient layer by the side of a transparent electrode, The optical path from the luminescence interface of said luminous layer to an interface with said metal electrode a luminous layer and said organic compound ingredient layer which remains by becoming thickness which one fourth of odd times, abbreviation, etc. for said wavelength lambda spread on said organic compound ingredient layer by the side of said transparent electrode the 2nd organic compound ingredient layer formation process which carries out a laminating and forms said organic compound ingredient layer by the side of a metal electrode, and the metal-electrode formation process which forms a metal electrode on the organic compound ingredient layer by the side of said metal electrode — since — the manufacture approach of the organic electroluminescent element characterized by becoming.
[Claim 5] Said organic compound ingredient layer and metal electrode are the manufacture approach of the organic electroluminescent element according to claim 3 or 4 characterized by a laminating being carried out by vacuum evaporationo.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention uses the organic compound which presents the electroluminescence which emits light by impregnation of a current, and relates to the organic electroluminescent element (henceforth an organic EL device) equipped with the luminous layer which consists of this organic electroluminescence ingredient, and its manufacture approach.
[0002]
[Description of the Prior Art] Generally, as shown in drawing 1 , the organic EL device using an organic compound ingredient is a component of the current impregnation mold which has diode characteristics, and is a component which emits light by the brightness corresponding to the amount of currents. The plurality of this component is arranged in the shape of a matrix, and a display panel is being developed (JP,8-315981,A). The substrate which carried out patterning, formed on the glass substrate 2 as the screen by etching after forming the film of indium stannic acid ghost ******** ITO, and was made into the anode plate 3 of a transparent electrode is used. Each organic EL device 1 which constitutes a display panel has the structure which carried out the laminating of two or more organic compound ingredient layers 4 which contain a luminous layer on a transparent electrode 3 using vacuum deposition etc., and the cathode 5 which consists of a metal electrode one by one. Moreover, the electron hole transport stratum functionale (a hole injection layer, electron hole transporting bed), the electronic transport stratum functionale (an electronic injection layer, electronic transporting bed), etc. are suitably prepared other than a luminous layer as an organic compound ingredient layer 4 if needed.
[0003] Since an organic compound ingredient layer is high resistance, he forms an organic compound ingredient layer thinly as much as possible, and is trying to lower driver voltage from the former.
[0004]
[Problem(s) to be Solved by the Invention] When forming an organic compound ingredient layer thinly as much as possible and manufacturing the organic EL device 1 of the above-mentioned configuration, in order to carry out sequential formation of each class by vacuum evaporationo etc. at a glass substrate 2 Since it will be hard to vapor-deposit a vacuum evaporationo particle with dust 6 in the periphery section of the lower point of contact if the dust 6 of a foreign matter solid-state etc. exists for example, on an anode plate 3 at the time of vacuum evaporationo of each class as shown in drawing 2 The electrode of dust 6 lower periphery section, i.e., shade part, 6a has the inclination for the thickness of the organic compound ingredient layer 4 to become thin compared with other fields. Consequently, an anode plate 3 and cathode 5 may approach near the dust 6, electric-field concentration may arise, and luminescence brightness may change locally. Moreover, an anode plate 3 and cathode 5 may contact depending on the case, a short circuit may arise, and it may lead to destruction of a component 1.
[0005] Then, although measures, such as washing of the substrate 2 before vacuum evaporationo of each class, were taken, it was difficult only now to remove the dust which once adhered thoroughly. The object of this invention is offering the organic EL device which controlled generating of the leakage current between a transparent electrode and a metal electrode, and its manufacture approach in view of the above-mentioned trouble.
[0006]
[Means for Solving the Problem] The organic electroluminescent element by this invention The organic compound ingredient layer which contains a transparent electrode and a luminous layer at least on the substrate of translucency, It is the organic electroluminescent element which the laminating of a metal electrode and the ** is carried out to order, they are formed in it, and has the interface of the maximum refractive-index level difference in said organic compound ingredient layer or said transparent electrode by the side of the transparent electrode bordering on the luminescence interface of said luminous layer. The organic compound ingredient layer by the side of said transparent electrode is characterized by being formed so that it may become more than the thickness that produces the minimal value between the luminous efficiency of the primary maximal value in the luminous efficiency property over the thickness by the side of the transparent electrode of said organic compound ingredient layer, and the secondary maximal value.
[0007] In the organic electroluminescent element by this invention, thickness by the side of the transparent electrode of said organic compound ingredient layer is characterized by the thing for which the optical path from the luminescence interface of said luminous layer which emits light considering the light of wavelength lambda as a principal component to the interface of said maximum refractive-index level difference spreads one fourth of even times, abbreviation, etc. for said wavelength lambda and which is formed so that it may become. It is the organic

electroluminescent element according to claim 2 characterized by the thing on which, as for the thickness by the side of the metal electrode of said organic compound ingredient layer, the optical path from the luminescence interface of said luminous layer to an interface with said metal electrode spreads one fourth of odd times, abbreviation, etc. for said wavelength lambda in the organic electroluminescent element by this invention, and which is formed so that it may become.

[0008] Moreover, the manufacture approach of the organic electroluminescent element by this invention The organic compound ingredient layer which contains a transparent electrode and a luminous layer at least on the substrate of translucency, It is the manufacture approach of an organic electroluminescent element of the laminating of a metal electrode and the ** being carried out to order, they being formed in it, and having the interface of the maximum refractive-index level difference in said organic compound ingredient layer or said transparent electrode by the side of the transparent electrode bordering on the luminescence interface of said luminous layer. One or more of said organic compound ingredient layers except the luminous layer which should make the light of wavelength lambda emit light as a principal component on the transparent electrode formed on the substrate of translucency By becoming thickness on which the optical path from the luminescence interface of said luminous layer to the interface of said maximum refractive-index level difference spreads one fourth of even times, abbreviation, etc. for said wavelength lambda The 1st organic compound ingredient layer formation process which carries out a laminating and forms said organic compound ingredient layer by the side of a transparent electrode, The optical path from the luminescence interface of said luminous layer to an interface with said metal electrode a luminous layer and said organic compound ingredient layer which remains by becoming thickness which one fourth of odd times, abbreviation, etc. for said wavelength lambda spread on said organic compound ingredient layer by the side of said transparent electrode the 2nd organic compound ingredient layer formation process which carries out a laminating and forms said organic compound ingredient layer by the side of a metal electrode, and the metal-electrode formation process which forms a metal electrode on the organic compound ingredient layer by the side of said metal electrode — since — it is characterized by becoming.

[0009] In the manufacture approach of the organic electroluminescent element by this invention, said organic compound ingredient layer and metal electrode are characterized by a laminating being carried out by vacuum evaporationo. According to this invention, the component which attained leak prevention can be offered, without worsening luminous efficiency (brightness ratio to a current) by using the phenomenon in which a high order luminous efficiency peak appears, and adjusting the thickness of an organic compound ingredient layer located between a transparent electrode and a luminous layer, if the thickness, especially transparent electrode pleural membrane thickness of an organic compound ingredient layer are thickened.

[0010]

[Embodiment of the Invention] The example of the organic EL device by this invention and its manufacture approach is explained referring to a drawing. As a result of investigating two or more properties of the organic EL device which thickened transparent electrode pleural membrane thickness of an organic compound ingredient layer one by one, by thickening transparent electrode pleural membrane thickness of an organic compound ingredient layer in an organic EL device, the artificer did the knowledge of the phenomenon in which a high order luminous efficiency peak appears, and resulted in this invention.

[0011] It decreases, so that it goes to the metal-electrode side with which distribution of the luminescence reinforcement in the inside of a luminous layer is strong with a metal electrode in the interface by the side of the transparent electrode with which an electron hole transporting bed etc. exists, and an electronic transporting bed etc. exists in an organic EL device, and it is the exponential distribution about the thickness of a luminous layer, and the interface by the side of this transparent electrode is known as a luminescence interface which has a luminescence peak on the strength. As shown in drawing 3 , in the organic EL device 1 of the structure which carried out the laminating of the transparent electrode 3 of ITO, two or more organic compound ingredient layers 4d and 4D containing a luminous layer, and the metal electrode 5 one by one, an organic compound ingredient layer is divided by 4d and metal-electrode side 4D a transparent electrode side bordering on the luminescence interface 10 of a luminous layer on a glass substrate 2. As shown in drawing 3 , in an organic EL device 1, it can be considered that the interface of a metal electrode 5 and organic compound ingredient layer 4D is a total reflection side. Therefore, total reflection of the light which faces to a metal electrode from the luminescence interface 10 of a luminous layer is carried out with a metal electrode 5, it passes the luminescence interface 10, and contributes to external luminescence. Of course, most light which faces to a transparent electrode 3 passes a substrate 2, and it contributes to external luminescence.

[0012] on the other hand, since the refractive-index level difference of a glass substrate 2 and a transparent electrode 3 is alike and larger than the refractive-index difference of other adjacent layers, the operation of the interface of the maximum refractive-index level difference is also remarkable in this transparent electrode side as a reflector. the organic compound ingredient layers 4d and 4D — a refractive index — in about 1.8 abbreviation, since the refractive index of a refractive index is about 1.5 abbreviation in about 2.0 abbreviation at the ITO transparent electrode 3 in the glass (soda lime glass) substrate 2, the refractive-index difference between 4d of organic compound ingredient layers and a transparent electrode 3 is 0.2, the refractive-index difference between a glass substrate 2 and a transparent electrode 3 is 0.5, and in a transparent electrode side, the refractive-index difference of a glass substrate 2 and a transparent electrode 3 is max. Therefore, with the light which returns from the luminescence interface 10 of a luminous layer to the luminescence interface 10 toward a transparent electrode 3, the small refractive-index differences between 4d of organic compound ingredient layers and a transparent

electrode 3 etc. are disregarded, and the maximum refractive-index level difference of a glass substrate 2 and a transparent electrode 3 is taken into consideration. In addition, the maximum refractive-index level difference can also form and form a high refractive-index ingredient not only in a glass substrate and a transparent electrode but in the interior of 4d of organic compound ingredient layers.

[0013] The light emission root which this generated like drawing 3 with the component at the luminescence interface Mainly carry out an outside echo with bleedoff and (2) metal electrodes toward the exterior directly from (1) luminescence interface, return to a luminescence interface, and it emits toward the exterior. And internal reflection is carried out with (3) glass, and it returns to a luminescence interface, and becomes whether to be bleedoff and ******** toward the exterior, and luminous efficiency is influenced by the nonconformity of interference of the light of (2) which returns to an interface, and (3). The design of the film optimal about the luminous layer of the organic compound ingredient layer which emits light considering the light of wavelength lambda as a principal component for below is explained.

[0014] First, the interference in the 4d light emission root is considered the transparent electrode side of the organic compound ingredient layer of the above (3). As shown in drawing 3 R> 3, when it is the refractive index n and Thickness d of the whole light which carries out internal reflection by the interface of a transparent electrode 3 and substrate glass 2, and returns to a luminescence interface, the optical-path-length 2nd is the sum total of the optical path length of an organic compound ingredient layer, and the optical path length of a transparent electrode, and is [0015].

[Equation 1] 2nd=2(norgdorg+nITOdITO)

(— the inside of a formula, and norg — the refractive index of 4d of organic compound ingredient layers — in dorg, nITO shows the refractive index of a transparent electrode 3, and dITO shows the thickness of a transparent electrode 3 for the thickness of 4d of organic compound ingredient layers, respectively —) — ** — it is expressed. Therefore, interference with the wavelength lambda which optical-path-length 2nd of this light to which it goes and comes back should emit for which light and take out, the light which returns when equal to the product of the wave number, and the light which emits light serves as max. Therefore, the optical path from the luminescence interface for thickness setting out of 4d of organic compound ingredient layers from which cross protection serves as max as shown in drawing 4 to the interface of the maximum refractive-index level difference is [0016].

[Equation 2] 2(norgdorg+nITOdITO) =j-lambdatherefore(norgdorg+nITOdITO) =2j- (lambda/4)

(— the inside of a formula, j= 1, and 2 and 3 — it is expressed integer) of ... If 4d of organic compound ingredient layers and the sum total thickness of a transparent electrode 3 are set up so that it may become near [this] the optical path, luminous efficiency will improve by interference. Namely, what is necessary is just to form the thickness by the side of the transparent electrode of an organic compound ingredient layer so that the optical path (norgdorg+nITOdITO) to the interface of the maximum refractive-index level difference may spread one fourth of even times, abbreviation, etc. for wavelength lambda and it may consist of a luminescence interface 10.

[0017] Furthermore, the interference in the light emission root of metal-electrode side 4D of the organic compound ingredient layer of the above (2) is considered. In the interface of a metal electrode 5 and metal-electrode side organic compound ingredient layer 4D, as shown in drawing 3 , since it is an outside echo, it is before and after the echo of light, and phase contrast pi arises. therefore, since it is expressed that optical-path-length 2nD when it is the refractive index n and Thickness D of metal-electrode side organic compound ingredient layer 4D of the whole light which returns to a luminescence interface, optical-path-length 2nD of this light to which it goes and comes back is shown in drawing 5 — as — lambda / 2lambda and 3lambda / 5lambda [2lambda and]/2lambda ... emits light, and when equal to the wavelength which should be taken out, interference with the returning light and the light which emits light serves as max. Therefore, the optical path from the thickness 10, i.e., the luminescence interface, of organic compound ingredient layer 4D from which cross protection serves as max to the interface of a metal electrode 5 is [0018].

[Equation 3] 2nD(s)=[2 (j-1)/2] lambdathereforenD = [2 (j-1)/4] It is expressed lambda (2 the inside of a formula, j= 1, 3 ... integer). If the thickness D of organic compound ingredient layer 4D is set up so that it may become near [this] the optical path, luminous efficiency will improve by interference. Namely, the thickness D by the side of the metal electrode of an organic compound ingredient layer should just form membranes so that the optical path nD to an interface with a metal electrode 5 may spread one fourth of odd times, abbreviation, etc. for wavelength lambda and may consist of a luminescence interface 10 of a luminous layer.

[0019] In manufacturing an organic EL device, as 1st organic compound ingredient layer formation process One or more of the organic compound ingredient layers except the luminous layer which should make the light of wavelength lambda emit light as a principal component on the transparent electrode formed on the substrate of translucency By becoming thickness which spreads one fourth of even times, abbreviation, etc. for wavelength lambda, the optical path from the luminescence interface of a luminous layer to the interface of the maximum refractive-index level difference carries out a laminating, and forms the organic compound ingredient layer by the side of a transparent electrode. Then, as 2nd organic compound ingredient layer formation process, by becoming thickness by which one fourth of odd times, abbreviation, etc. for wavelength lambda spread a luminous layer and the organic compound ingredient layer which remains on the organic compound ingredient layer by the side of a transparent electrode, the optical path from the luminescence interface of a luminous layer to an interface with a metal electrode carries out a laminating, forms the organic compound ingredient layer by the side of a metal electrode, and forms a metal electrode after that on the organic compound ingredient layer by the side of a metal electrode.

[0020] Thus, when thickness of an organic compound ingredient layer is gradually thickened for the above-mentioned component structure, the thickness whose phase of the light emission root corresponds carries out a sequential appearance, and the maximal value and the minimal value in the luminous efficiency property over thickness by the side of the transparent electrode of an organic compound ingredient layer come to be shown especially. When the thickness of an organic compound ingredient layer is set up near the primary maximal value in a thickness luminous efficiency property and this thickness was made to increase gradually conventionally, the inclination for luminous efficiency to fall gradually was known, but by thickening this thickness further, and setting up so that it may become more than the thickness that produces the minimal value between the luminous efficiency of the primary secondary maximal value in a thickness luminous efficiency property, luminous efficiency improves until it becomes the secondary maximal value.
[0021] The check by the experiment of the high order maximal value peak appearance in a thickness luminous efficiency property was performed. As the thickness of an electron hole transporting bed is changed and it is shown in drawing 6 , membranes are formed on a substrate 2 in order of transparent electrode (anode plate) 3 / hole injection layer 41 / electron hole transporting bed 42 / luminous layer 43 / electronic injection layer 44 / metal electrode (cathode) 5. Each ingredient (thickness) Two or more organic EL devices which made Quinacridone addition (60nm) / aluminium-lithium alloy aluminum-Li (100nm) at ITO(110nm)/MTDATA(25nm)/TPD (40-200nm) / aluminum oxine chelate Alq3 were produced. A luminous layer emits light considering light with a wavelength of 525nm as a principal component.
[0022] The electrical-potential-difference value (withstand voltage) just before impressing forward voltage (electrical potential difference of the direction where a component emits light), measuring brightness current letter-of-intent effectiveness, brightness effectiveness, and external quantum efficiency, impressing the driver voltage concerning the ends of the component when supplying a fixed current to the forward direction so that it may become fixed brightness luminescence further, and reverse voltage and a component's breaking namely, leaking about each component was measured. Drawing 7 shows the property of the letter-of-intent effectiveness about TPD thickness, brightness effectiveness, and external quantum efficiency. Drawing 8 shows the property of the driver voltage about TPD thickness, and reverse voltage.
[0023] When it is surmised that the primary peak produces it near the 20nm thickness although pair current brightness effectiveness has not appeared in drawing and TPD thickness is further thickened so that clearly from drawing 7 , it turns out that the minimal value arose near the 100nm thickness, and the secondary peak has arisen near the 180nm thickness. Therefore, a practical component property is acquired by doubling with a high order peak, even if it thickens TPD thickness. That is, the component which has TPD which serves as 170-200nm thickness preferably 120nm or more of thickness exceeding the minimal value between the luminous efficiency of the primary maximal value in the luminous efficiency property over the TPD thickness by the side of the transparent electrode of an organic compound ingredient layer and the secondary maximal value turns into a practical component. Moreover, when this component thickens TPD thickness so that clearly from drawing 7 , as for pair current driver voltage and a durable electrical potential difference, it turns out that it goes up and has withstand voltage property sufficient in 120nm or more of thickness which produces the minimal value between the luminous efficiency of the primary maximal value and the secondary maximal value.
[0024] Furthermore, leak of a next door component cannot generate sufficiently easily the closing-in part of the organic compound ingredient layer 4 in partial 6a which becomes the shade of dust as shown in drawing 2 by thickening thickness of the organic compound ingredient layer by which vacuum evaporationo formation is carried out by this invention, either. In the 2nd organic compound ingredient layer formation process which carries out a laminating, a luminous layer and the organic compound ingredient layer which remains on the organic compound ingredient layer by the side of the transparent electrode of the above-mentioned example Although the optical path from the luminescence interface of a luminous layer to an interface with a metal electrode forms the organic compound ingredient layer by the side of a metal electrode by becoming thickness which spreads one fourth of odd times, abbreviation, etc. for wavelength lambda In order to raise this in consideration of the viewing-angle dependency of brightness, according to a thickness brightness damping property, the organic compound ingredient layer by the side of the metal electrode containing a luminous layer may be formed more thinly than setting-out thickness as indicated by patent No. 2843924.
[0025] Moreover, although only the interface of the glass substrate 2 which is the interface of the maximum refractive-index level difference, and a transparent electrode 3 was taken into consideration as a reflector in the above-mentioned example, you may utilize as a reflector positively by preparing a translucent layer in the meantime. Moreover, what is necessary is to be before and after the echo of light and just to set up Thickness D in consideration of phase contrast pi arising, when making an interface act as a reflecting layer using the glass substrate which has an extremely larger refractive index than the refractive index of a transparent electrode. Moreover, the structure which formed the electron hole transporting bed on the ITO anode plate 1, without changing the thickness of the hole injection layer instead of an electron hole transporting bed, and forming a hole injection layer is sufficient.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention uses the organic compound which presents the electroluminescence which emits light by impregnation of a current, and relates to the organic electroluminescent element (henceforth an organic EL device) equipped with the luminous layer which consists of this organic electroluminescence ingredient, and its manufacture approach.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Generally, as shown in drawing 1 , the organic EL device using an organic compound ingredient is a component of the current impregnation mold which has diode characteristics, and is a component which emits light by the brightness corresponding to the amount of currents. The plurality of this component is arranged in the shape of a matrix, and a display panel is being developed (JP,8-315981,A). The substrate which carried out patterning, formed on the glass substrate 2 as the screen by etching after forming the film of indium stannic acid ghost ******** ITO, and was made into the anode plate 3 of a transparent electrode is used. Each organic EL device 1 which constitutes a display panel has the structure which carried out the laminating of two or more organic compound ingredient layers 4 which contain a luminous layer on a transparent electrode 3 using vacuum deposition etc., and the cathode 5 which consists of a metal electrode one by one. Moreover, the electron hole transport stratum functionale (a hole injection layer, electron hole transporting bed), the electronic transport stratum functionale (an electronic injection layer, electronic transporting bed), etc. are suitably prepared other than a luminous layer as an organic compound ingredient layer 4 if needed.
[0003] Since an organic compound ingredient layer is high resistance, he forms an organic compound ingredient layer thinly as much as possible, and is trying to lower driver voltage from the former.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] When forming an organic compound ingredient layer thinly as much as possible and manufacturing the organic EL device 1 of the above-mentioned configuration, in order to carry out sequential formation of each class by vacuum evaporationo etc. at a glass substrate 2 Since it will be hard to vapor-deposit a vacuum evaporationo particle with dust 6 in the periphery section of the lower point of contact if the dust 6 of a foreign matter solid-state etc. exists for example, on an anode plate 3 at the time of vacuum evaporationo of each class as shown in drawing 2 The electrode of dust 6 lower periphery section, i.e., shade part, 6a has the inclination for the thickness of the organic compound ingredient layer 4 to become thin compared with other fields. Consequently, an anode plate 3 and cathode 5 may approach near the dust 6, electric-field concentration may arise, and luminescence brightness may change locally. Moreover, an anode plate 3 and cathode 5 may contact depending on the case, a short circuit may arise, and it may lead to destruction of a component 1.
[0005] Then, although measures, such as washing of the substrate 2 before vacuum evaporationo of each class, were taken, it was difficult only now to remove the dust which once adhered thoroughly. The object of this invention is offering the organic EL device which controlled generating of the leakage current between a transparent electrode and a metal electrode, and its manufacture approach in view of the above-mentioned trouble.

[Translation done.]

MEANS

[Means for Solving the Problem] The organic electroluminescent element by this invention The organic compound ingredient layer which contains a transparent electrode and a luminous layer at least on the substrate of translucency, It is the organic electroluminescent element which the laminating of a metal electrode and the ** is carried out to order, they are formed in it, and has the interface of the maximum refractive-index level difference in said organic compound ingredient layer or said transparent electrode by the side of the transparent electrode bordering on the luminescence interface of said luminous layer. The organic compound ingredient layer by the side of said transparent electrode is characterized by being formed so that it may become more than the thickness that produces the minimal value between the luminous efficiency of the primary maximal value in the luminous efficiency property over the thickness by the side of the transparent electrode of said organic compound ingredient layer, and the secondary maximal value.
[0007] In the organic electroluminescent element by this invention, thickness by the side of the transparent electrode of said organic compound ingredient layer is characterized by the thing for which the optical path from the luminescence interface of said luminous layer which emits light considering the light of wavelength lambda as a principal component to the interface of said maximum refractive-index level difference spreads one fourth of even times, abbreviation, etc. for said wavelength lambda and which is formed so that it may become. It is the organic electroluminescent element according to claim 2 characterized by the thing on which, as for the thickness by the side of the metal electrode of said organic compound ingredient layer, the optical path from the luminescence interface of said luminous layer to an interface with said metal electrode spreads one fourth of odd times, abbreviation, etc. for said wavelength lambda in the organic electroluminescent element by this invention, and which is formed so that it may become.
[0008] Moreover, the manufacture approach of the organic electroluminescent element by this invention The organic compound ingredient layer which contains a transparent electrode and a luminous layer at least on the substrate of translucency, It is the manufacture approach of an organic electroluminescent element of the laminating of a metal electrode and the ** being carried out to order, they being formed in it, and having the interface of the maximum refractive-index level difference in said organic compound ingredient layer or said transparent electrode by the side of the transparent electrode bordering on the luminescence interface of said luminous layer. One or more of said organic compound ingredient layers except the luminous layer which should make the light of wavelength lambda emit light as a principal component on the transparent electrode formed on the substrate of translucency By becoming thickness on which the optical path from the luminescence interface of said luminous layer to the interface of said maximum refractive-index level difference spreads one fourth of even times, abbreviation, etc. for said wavelength lambda The 1st organic compound ingredient layer formation process which carries out a laminating and forms said organic compound ingredient layer by the side of a transparent electrode, The optical path from the luminescence interface of said luminous layer to an interface with said metal electrode a luminous layer and said organic compound ingredient layer which remains by becoming thickness which one fourth of odd times, abbreviation, etc. for said wavelength lambda spread on said organic compound ingredient layer by the side of said transparent electrode the 2nd organic compound ingredient layer formation process which carries out a laminating and forms said organic compound ingredient layer by the side of a metal electrode, and the metal-electrode formation process which forms a metal electrode on the organic compound ingredient layer by the side of said metal electrode — since — it is characterized by becoming.
[0009] In the manufacture approach of the organic electroluminescent element by this invention, said organic compound ingredient layer and metal electrode are characterized by a laminating being carried out by vacuum evaporationo. According to this invention, the component which attained leak prevention can be offered, without worsening luminous efficiency (brightness ratio to a current) by using the phenomenon in which a high order luminous efficiency peak appears, and adjusting the thickness of an organic compound ingredient layer located between a transparent electrode and a luminous layer, if the thickness, especially transparent electrode pleural membrane thickness of an organic compound ingredient layer are thickened.
[0010]
[Embodiment of the Invention] The example of the organic EL device by this invention and its manufacture approach is explained referring to a drawing. As a result of investigating two or more properties of the organic EL device which thickened transparent electrode pleural membrane thickness of an organic compound ingredient layer one by one, by thickening transparent electrode pleural membrane thickness of an organic compound ingredient layer in an organic EL device, the artificer did the knowledge of the phenomenon in which a high order luminous efficiency peak

appears, and resulted in this invention.
[0011] It decreases, so that it goes to the metal-electrode side with which distribution of the luminescence reinforcement in the inside of a luminous layer is strong with a metal electrode in the interface by the side of the transparent electrode with which an electron hole transporting bed etc. exists, and an electronic transporting bed etc. exists in an organic EL device, and it is the exponential distribution about the thickness of a luminous layer, and the interface by the side of this transparent electrode is known as a luminescence interface which has a luminescence peak on the strength. As shown in drawing 3 , in the organic EL device 1 of the structure which carried out the laminating of the transparent electrode 3 of ITO, two or more organic compound ingredient layers 4d and 4D containing a luminous layer, and the metal electrode 5 one by one, an organic compound ingredient layer is divided by 4d and metal-electrode side 4D a transparent electrode side bordering on the luminescence interface 10 of a luminous layer on a glass substrate 2. As shown in drawing 3 , in an organic EL device 1, it can be considered that the interface of a metal electrode 5 and organic compound ingredient layer 4D is a total reflection side. Therefore, total reflection of the light which faces to a metal electrode from the luminescence interface 10 of a luminous layer is carried out with a metal electrode 5, it passes the luminescence interface 10, and contributes to external luminescence. Of course, most light which faces to a transparent electrode 3 passes a substrate 2, and it contributes to external luminescence.
[0012] on the other hand, since the refractive-index level difference of a glass substrate 2 and a transparent electrode 3 is alike and larger than the refractive-index difference of other adjacent layers, the operation of the interface of the maximum refractive-index level difference is also remarkable in this transparent electrode side as a reflector. the organic compound ingredient layers 4d and 4D — a refractive index — in about 1.8 abbreviation, since the refractive index of a refractive index is about 1.5 abbreviation in about 2.0 abbreviation at the ITO transparent electrode 3 in the glass (soda lime glass) substrate 2, the refractive-index difference between 4d of organic compound ingredient layers and a transparent electrode 3 is 0.2, the refractive-index difference between a glass substrate 2 and a transparent electrode 3 is 0.5, and in a transparent electrode side, the refractive-index difference of a glass substrate 2 and a transparent electrode 3 is max. Therefore, with the light which returns from the luminescence interface 10 of a luminous layer to the luminescence interface 10 toward a transparent electrode 3, the small refractive-index differences between 4d of organic compound ingredient layers and a transparent electrode 3 etc. are disregarded, and the maximum refractive-index level difference of a glass substrate 2 and a transparent electrode 3 is taken into consideration. In addition, the maximum refractive-index level difference can also form and form a high refractive-index ingredient not only in a glass substrate and a transparent electrode but in the interior of 4d of organic compound ingredient layers.
[0013] The light emission root which this generated like drawing 3 with the component at the luminescence interface Mainly carry out an outside echo with bleedoff and (2) metal electrodes toward the exterior directly from (1) luminescence interface, return to a luminescence interface, and it emits toward the exterior. And internal reflection is carried out with (3) glass, and it returns to a luminescence interface, and becomes whether to be bleedoff and ******** toward the exterior, and luminous efficiency is influenced by the nonconformity of interference of the light of (2) which returns to an interface, and (3). The design of the film optimal about the luminous layer of the organic compound ingredient layer which emits light considering the light of wavelength lambda as a principal component for below is explained.
[0014] First, the interference in the 4d light emission root is considered the transparent electrode side of the organic compound ingredient layer of the above (3). As shown in drawing 3 R> 3, when it is the refractive index n and Thickness d of the whole light which carries out internal reflection by the interface of a transparent electrode 3 and substrate glass 2, and returns to a luminescence interface, the optical-path-length 2nd is the sum total of the optical path length of an organic compound ingredient layer, and the optical path length of a transparent electrode, and is [0015].
[Equation 1] 2nd=2(norgdorg+nITOdITO)
(— the inside of a formula, and norg — the refractive index of 4d of organic compound ingredient layers — in dorg, nITO shows the refractive index of a transparent electrode 3, and dITO shows the thickness of a transparent electrode 3 for the thickness of 4d of organic compound ingredient layers, respectively —) — ** — it is expressed. Therefore, interference with the wavelength lambda which optical-path-length 2nd of this light to which it goes and comes back should emit for which light and take out, the light which returns when equal to the product of the wave number, and the light which emits light serves as max. Therefore, the optical path from the luminescence interface for thickness setting out of 4d of organic compound ingredient layers from which cross protection serves as max as shown in drawing 4 to the interface of the maximum refractive-index level difference is [0016].
[Equation 2] 2(norgdorg+nITOdITO) =j-lambdatherefore(norgdorg+nITOdITO) =2j- (lambda/4)
(— the inside of a formula, j= 1, and 2 and 3 — it is expressed integer) of ... If 4d of organic compound ingredient layers and the sum total thickness of a transparent electrode 3 are set up so that it may become near [this] the optical path, luminous efficiency will improve by interference. Namely, what is necessary is just to form the thickness by the side of the transparent electrode of an organic compound ingredient layer so that the optical path (norgdorg+nITOdITO) to the interface of the maximum refractive-index level difference may spread one fourth of even times, abbreviation, etc. for wavelength lambda and it may consist of a luminescence interface 10.
[0017] Furthermore, the interference in the light emission root of metal-electrode side 4D of the organic compound ingredient layer of the above (2) is considered. In the interface of a metal electrode 5 and metal-electrode side organic compound ingredient layer 4D, as shown in drawing 3 , since it is an outside echo, it is before and after the

echo of light, and phase contrast pi arises. therefore, since it is expressed that optical-path-length 2nD when it is the refractive index n and Thickness D of metal-electrode side organic compound ingredient layer 4D of the whole light which returns to a luminescence interface, optical-path-length 2nD of this light to which it goes and comes back is shown in drawing 5 -- as -- lambda / 2lambda and 3lambda / 5lambda [2lambda and]/2lambda ... emits light, and when equal to the wavelength which should be taken out, interference with the returning light and the light which emits light serves as max. Therefore, the optical path from the thickness 10, i.e., the luminescence interface, of organic compound ingredient layer 4D from which cross protection serves as max to the interface of a metal electrode 5 is [0018].
[Equation 3] 2nD(s)=[2 (j-1)/2] lambdathereforenD = [2 (j-1)/4] It is expressed lambda (2 the inside of a formula, j= 1, 3 ... integer). If the thickness D of organic compound ingredient layer 4D is set up so that it may become near [this] the optical path, luminous efficiency will improve by interference. Namely, the thickness D by the side of the metal electrode of an organic compound ingredient layer should just form membranes so that the optical path nD to an interface with a metal electrode 5 may spread one fourth of odd times, abbreviation, etc. for wavelength lambda and may consist of a luminescence interface 10 of a luminous layer.
[0019] In manufacturing an organic EL device, as 1st organic compound ingredient layer formation process One or more of the organic compound ingredient layers except the luminous layer which should make the light of wavelength lambda emit light as a principal component on the transparent electrode formed on the substrate of translucency By becoming thickness which spreads one fourth of even times, abbreviation, etc. for wavelength lambda, the optical path from the luminescence interface of a luminous layer to the interface of the maximum refractive-index level difference carries out a laminating, and forms the organic compound ingredient layer by the side of a transparent electrode. Then, as 2nd organic compound ingredient layer formation process, by becoming thickness by which one fourth of odd times, abbreviation, etc. for wavelength lambda spread a luminous layer and the organic compound ingredient layer which remains on the organic compound ingredient layer by the side of a transparent electrode, the optical path from the luminescence interface of a luminous layer to an interface with a metal electrode carries out a laminating, forms the organic compound ingredient layer by the side of a metal electrode, and forms a metal electrode after that on the organic compound ingredient layer by the side of a metal electrode.
[0020] Thus, when thickness of an organic compound ingredient layer is gradually thickened for the above-mentioned component structure, the thickness whose phase of the light emission root corresponds carries out a sequential appearance, and the maximal value and the minimal value in the luminous efficiency property over thickness by the side of the transparent electrode of an organic compound ingredient layer come to be shown especially. When the thickness of an organic compound ingredient layer is set up near the primary maximal value in a thickness luminous efficiency property and this thickness was made to increase gradually conventionally, the inclination for luminous efficiency to fall gradually was known, but by thickening this thickness further, and setting up so that it may become more than the thickness that produces the minimal value between the luminous efficiency of the primary secondary maximal value in a thickness luminous efficiency property, luminous efficiency improves until it becomes the secondary maximal value.
[0021] The check by the experiment of the high order maximal value peak appearance in a thickness luminous efficiency property was performed. As the thickness of an electron hole transporting bed is changed and it is shown in drawing 6 , membranes are formed on a substrate 2 in order of transparent electrode (anode plate) 3 / hole injection layer 41 / electron hole transporting bed 42 / luminous layer 43 / electronic injection layer 44 / metal electrode (cathode) 5. Each ingredient (thickness) Two or more organic EL devices which made Quinacridone addition (60nm) / aluminium-lithium alloy aluminum-Li (100nm) at ITO(110nm)/MTDATA(25nm)/TPD (40-200nm) / aluminum oxine chelate Alq3 were produced. A luminous layer emits light considering light with a wavelength of 525nm as a principal component.
[0022] The electrical-potential-difference value (withstand voltage) just before impressing forward voltage (electrical potential difference of the direction where a component emits light), measuring brightness current letter-of-intent effectiveness, brightness effectiveness, and external quantum efficiency, impressing the driver voltage concerning the ends of the component when supplying a fixed current to the forward direction so that it may become fixed brightness luminescence further, and reverse voltage and a component's breaking namely, leaking about each component was measured. Drawing 7 shows the property of the letter-of-intent effectiveness about TPD thickness, brightness effectiveness, and external quantum efficiency. Drawing 8 shows the property of the driver voltage about TPD thickness, and reverse voltage.
[0023] When it is surmised that the primary peak produces it near the 20nm thickness although pair current brightness effectiveness has not appeared in drawing and TPD thickness is further thickened so that clearly from drawing 7 , it turns out that the minimal value arose near the 100nm thickness, and the secondary peak has arisen near the 180nm thickness. Therefore, a practical component property is acquired by doubling with a high order peak, even if it thickens TPD thickness. That is, the component which has TPD which serves as 170-200nm thickness preferably 120nm or more of thickness exceeding the minimal value between the luminous efficiency of the primary maximal value in the luminous efficiency property over the TPD thickness by the side of the transparent electrode of an organic compound ingredient layer and the secondary maximal value turns into a practical component. Moreover, when this component thickens TPD thickness so that clearly from drawing 7 , as for pair current driver voltage and a durable electrical potential difference, it turns out that it goes up and has withstand voltage property sufficient in 120nm or more of thickness which produces the minimal value between the luminous efficiency of the

primary maximal value and the secondary maximal value.
[0024] Furthermore, leak of a next door component cannot generate sufficiently easily the closing-in part of the organic compound ingredient layer 4 in partial 6a which becomes the shade of dust as shown in drawing 2 by thickening thickness of the organic compound ingredient layer by which vacuum evaporationo formation is carried out by this invention, either. In the 2nd organic compound ingredient layer formation process which carries out a laminating, a luminous layer and the organic compound ingredient layer which remains on the organic compound ingredient layer by the side of the transparent electrode of the above-mentioned example Although the optical path from the luminescence interface of a luminous layer to an interface with a metal electrode forms the organic compound ingredient layer by the side of a metal electrode by becoming thickness which spreads one fourth of odd times, abbreviation, etc. for wavelength lambda In order to raise this in consideration of the viewing-angle dependency of brightness, according to a thickness brightness damping property, the organic compound ingredient layer by the side of the metal electrode containing a luminous layer may be formed more thinly than setting-out thickness as indicated by patent No. 2843924.
[0025] Moreover, although only the interface of the glass substrate 2 which is the interface of the maximum refractive-index level difference, and a transparent electrode 3 was taken into consideration as a reflector in the above-mentioned example, you may utilize as a reflector positively by preparing a translucent layer in the meantime. Moreover, what is necessary is to be before and after the echo of light and just to set up Thickness D in consideration of phase contrast pi arising, when making an interface act as a reflecting layer using the glass substrate which has an extremely larger refractive index than the refractive index of a transparent electrode. Moreover, the structure which formed the electron hole transporting bed on the ITO anode plate 1, without changing the thickness of the hole injection layer instead of an electron hole transporting bed, and forming a hole injection layer is sufficient.

[Translation done.]

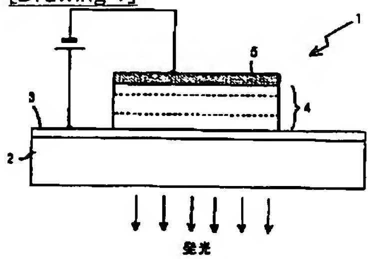
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing an organic EL device.
[Drawing 2] It is the sectional view showing the organic EL device in a manufacture process.
[Drawing 3] It is the sectional view showing the organic EL device by this invention.
[Drawing 4] It is the sectional view showing the internal reflection in the organic compound ingredient layer of the organic EL device by this invention.
[Drawing 5] It is the sectional view showing the outside echo in the organic compound ingredient layer of the organic EL device by this invention.
[Drawing 6] It is the sectional view of the example of the organic EL device by this invention.
[Drawing 7] It is the graph which shows the property of the letter-of-intent effectiveness about the electron hole transporting bed thickness of the organic EL device by this invention, brightness effectiveness, and external quantum efficiency.
[Drawing 8] It is the graph which shows the property of the driver voltage about the electron hole transporting bed thickness of the organic EL device by this invention, and reverse voltage.
[Drawing 9] It is the sectional view of other examples of the organic EL device by this invention.
[Description of Notations]
1 Organic EL Device
2 Transparence Substrate
3 Transparent Electrode
4 Organic Compound Ingredient Layer
5 Metal Electrode
10 Luminescence Interface
41 Hole Injection Layer
42 Electron Hole Transporting Bed
43 Luminous Layer
44a Electronic transporting bed
44 Electronic Injection Layer

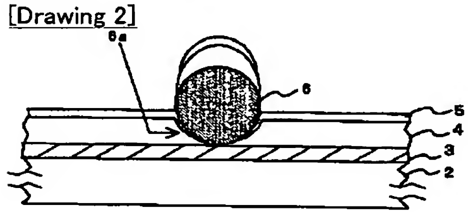
[Translation done.]

DRAWINGS

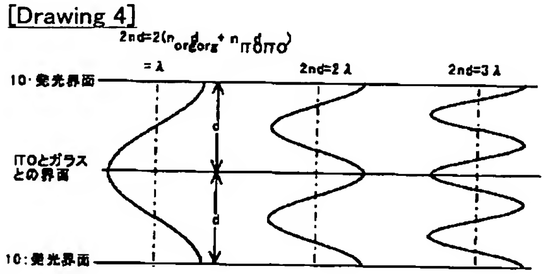
[Drawing 1]



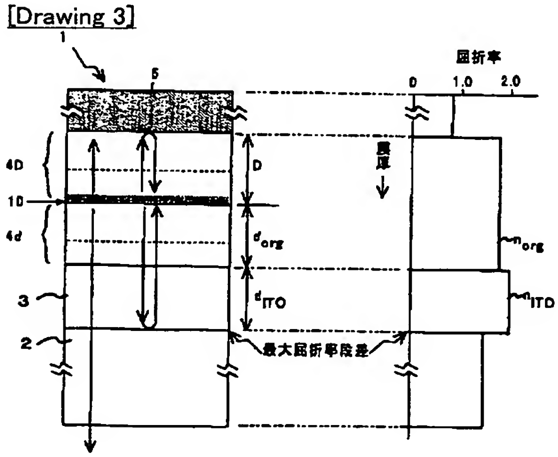
[Drawing 2]



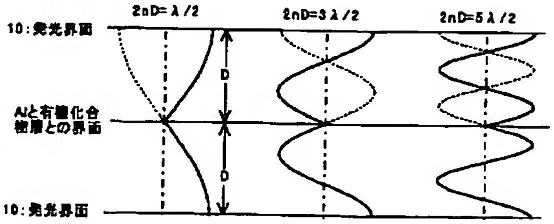
[Drawing 4]



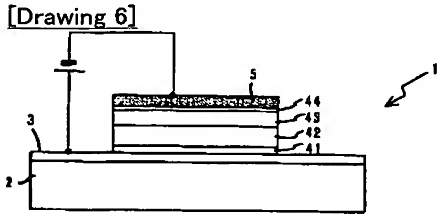
[Drawing 3]



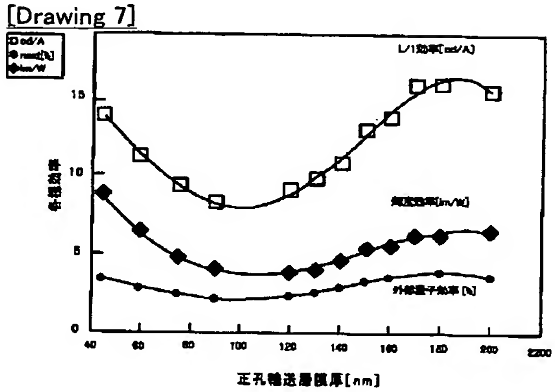
[Drawing 5]



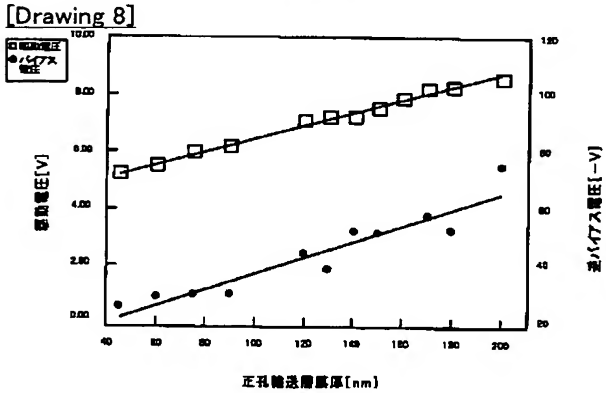
[Drawing 6]



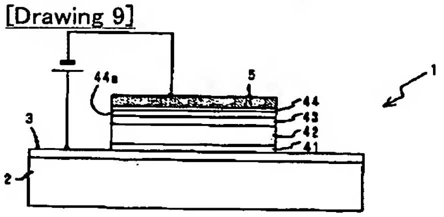
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]